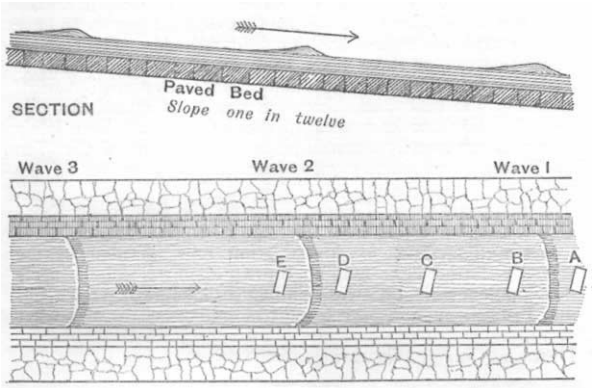
the level paved bed presents the appearance of a ladder of low advancing waves occurring at regular intervals of about 40 feet over the lower slope of one in twelve, and at less regular intervals of about 12 feet over the steeper slope of one in nine.

Of the motion of the stream over the lower slope of one in twelve the following particulars were noticed :—

A floating body travels at the rate of 9½ feet per second, but this does not represent the speed of any part of the water.



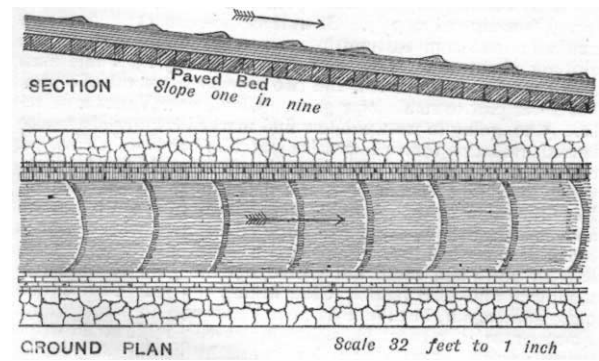
The wave-heads advanced at the rate of 13 feet a second, and the intervening stretches of stiller water (as nearly as I could judge) at about 6 feet a second. It is evident that the upper and lower currents are travelling at different rates—the bottom current retarded by friction, the surface current advanced over it by gravitation, accumulating at intervals of about 40 feet into wave-heads of a semicircular form, the sides being bent back by latent friction.

The motion of a floating body in the stream of advancing waves is very peculiar. A piece of wood thrown in at A, just in front of the advancing wave, No. 1, is *for a moment* carried forward by it, but the slower lower stratum gains the mastery, and the wave advances in front of the wood, which is successively found at B, C, D, E, &c. *relatively* to the advancing wave-heads, the floating wood recedes up the stream, though actually advancing at a rate between that of the upper and under or ground current.

The waves occur at intervals of about 40 feet, and occupy a trifle over 3 seconds in passing over the space that separates them.

Of the motion of the stream over the steeper slope of about one in nine, the following particulars were noticed :—

A floating body travels at the rate of 12½ feet per second. The wave-heads were less clearly defined than on the less steep

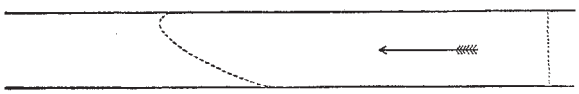


incline, and it was difficult to accurately measure their rate of advance, but as in the other case they rapidly overshot a floating piece of wood. They occur at much shorter intervals (about 12 feet) than on the less steep incline. GEORGE MAW

Interlaken, June 28

I may mention that my observations referred to by Mr. Maw were made upon the current of the River Severn with a view to explain the cause why the men who navigate the barges, in descending this river by the force of the current only are enabled to steer with a moderate degree of effectiveness. The power results from the different velocities of the current at and beneath the surface. A little below the surface, roughly speaking at about one-fifth of the actual depth, the current seems to have its maximum velocity, and consequently the hull of the vessel floating down the stream is immersed in water flowing more rapidly than that at the surface, on which the rudder for the most part acts.

I was enabled to demonstrate this fact by the following simple experiment. Having noticed that leaves of trees, after lying for some time on the ground and nearly saturated with water, become almost of the same, and after a longer time of greater, specific gravity than water, it occurred to me that such leaves, while in the first-named stage, would show what I desired to know, namely, the relative velocities of the stream at different levels below its surface. Two straight bars of wood, each about thirteen or fourteen feet long, were tied together at one end, between the two the foot-stalks of a number of poplar leaves were inserted (this kind was chosen because of the length of the footstalk for insertion between the bars, and its brightness of colour rendering it more visible in the depth of the water) ; the bars were charged with the leaves at intervals of about three inches, and then, choosing a place where the river was of suitable depth, the bars charged with leaves were plunged into the water, the connected ends touching the ground. The water was so clear that every leaf remained visible ; then I opened the ends of the bars at the surface, and was gratified by seeing every leaf floating away and preserving as to depth very nearly the same relative position. Floating with the stream in my boat, I soon saw those nearest the bottom gradually lagging behind, and still more was I gratified when, after proceeding about forty yards, the leaves that were about two feet below the surface had distanced those at the surface in an unmistakable manner by at least three feet, the current being about four feet per second. The whole series forming a curve as is here shown.



Greatly pleased with this first experiment, I was not satisfied till I had repeated it again and again, not only on that occasion, but when the wind was blowing down the river, and therefore should have accelerated the leaf at the surface, which it undoubtedly did ; but only the leaf on the surface, and that to a much smaller degree than I expected, and it left unaffected all that were beneath. A calm day is the best for this experiment, because the ripple renders it difficult to see below the surface. The water must of course be clear, a condition with which we are much favoured in this river. Mr. Maw's observations of the different velocities of the pieces of wood and the wave heads are quite in harmony with mine ; the depth of the water in the stream at Merligen would be only a few inches, and pieces of wood were immersed so deeply that they would be more affected by the retarded current four-fifths below than by that one-fifth at the surface. J. P. G. SMITH

Sweyney Cliff, Coalport, Shropshire

Ocean Swells

THE late melancholy accident in Fingal's Cave, Staffa, by which three lives were lost, when several visitors to the island were washed off the railed ledge by a large wave which suddenly and unexpectedly broke into the cave, leads me to submit the following account of a somewhat similar wave and on the same part of the coast.

On the 4th inst. I took a small 5-ton sailing-boat from Oban to the Island of Lismore. We had a steady south-west breeze, going there with an even slight swell in the more open part, coming up the Firth of Lorne from the Atlantic. On our return the wind dropped to a dead calm and shifted to the south-eastward, so that to get back we took to the oars, the water becoming perfectly smooth as we neared Kerrera (between 5 and half-past 5 o'clock), when, standing at the bow, and looking seaward, I was surprised to see a broad wave or long swell coming from the south-westward, followed by two minor undulations. They

passed the boat, which rose and fell to them as they swept on. Ahead was the small island near the north-west entrance to Oban Harbour; Kerrera Island was close on the right or starboard bow. The sea was so calm, there was no sign of wash on either shore. As the wave rolled in I watched it, and after a few seconds the white line of surf became visible and the noise of the same following told of its breaking on the rocks with some violence. It was not the wash of any steamer, as the boatman at first unthinkingly surmised, for in the first place it was too broad a dome of water, many of our boat's lengths, into which the few short waves even of the largest steamers could not resolve themselves; secondly, there was no steamer in sight, nor had any lately gone by, save the Duke of Argyll's steam yacht, which had passed near us more than half an hour previously.

Such a wave could not have originated in the narrow channel between Mull and the mainland, but must have come in from the Atlantic, and had its origin, I imagine, in some far distant submarine disturbance. I have seen a report in the papers of an earthquake in Jersey, and I am informed by some friends lately returned from Cornwall (near St. Michael's Mount), that on August 26, about 4 p.m., when watching a seine net being pulled ashore, a wave larger than usual—described as a long black line, seen for a long time—rolled in. Perhaps others may have noted similar waves at other parts of the coast, and been able to record the exact time. H. H. GODWIN-AUSTEN

Deepdale, Reigate, September 9

Salmon-Breeding

ON August 28 an examination was made at Lord Lauderdale's fish-rearing ponds at Howietoun into the condition of the young salmon and hybrid Salmonidæ, and with the following interesting results:—

A hybrid was taken from Pond No. 3 which measured 6·5 inches in length; it was one of about 190, all much the same size, which were raised from the eggs of the Lochleven trout fertilised from the milt of the American char, *Salmo fontinalis*, on November 15, 1882. The specimen was a male with the milt nearly fully developed; the fish would evidently have bred this winter.

A hybrid was removed from Pond No. 4 which measured 7·5 inches in length; it was one of about 90, and raised from the ova of the American char milted from a Scotch char from Loch Rannock on November 15, 1882. It also was a male with the milt as fully developed as in the preceding hybrid.

Segregation in these ponds has been most rigidly carried out, and the results show that trout and char, or two species of char, will interbreed and give fertile offspring. A few more months will decide whether the females are as forward as the males, and whether the milt itself is prolific or not so; also to what extent hybrids will interbreed.

A hybrid was removed from the Octagon Pond at Craigend which measured 6·5 inches in length; it was one of 212, and raised from the ova of the Lochleven trout, fertilised by salmon milt on December 24, 1881. It was a barren female; whether any will be fertile time will show.

A grilse was taken from the salmon pond at Howietoun which measured fourteen inches in length; there are a large number, but they are in too deep water to count. These fish were raised from the ova and milt of pure salmon taken from the Teith in December, 1880. The specimen was a female, with the ova well advanced, being 0·1 inch in diameter, and would have bred this season. This fish was well nourished, with eleven rows of scales between the adipose dorsal and the lateral line, and sixty cæcal appendages. This solves the question that our salmon may not only be reared in a healthy state in suitable ponds of fresh water, but also, if properly cared for, will breed without descending to the sea. Last year the milt of the pars from this pond were successfully used for breeding purposes.

FRANCIS DAY

Hydrodictyon in the Eastern Counties

IT may interest some of your readers to know that *Hydrodictyon utriculatum* (Roth), reckoned by Dillwyn among the rarest of the fresh-water Algæ, and now generally described as confined to the ditches and pools of the Midland and Southern Counties of England (W. J. Hooker, 1833; Harvey, 1841; Hassall, 1845; and Griffith's "Micrographical Dictionary," 1883), can again be claimed as an inhabitant of the *Eastern* Counties. A few days ago I found a fine and well-grown specimen in the river just above the well known sluice at Denver.

In the earlier half of the present century Cambridge seems to have been the centre for its distribution. Dillwyn, in 1809, relates that he received his specimen from the pool of the old Botanic Garden. Harvey, in 1841, says that he has fine specimens from Prof. Henslow, gathered in a pond in the Botanic Garden at Cambridge, where the plant has existed for many years. Hassall, in 1845, repeats Harvey's words, again on the authority of Prof. Henslow. Since that time it appears to have become completely extinct in this neighbourhood. The Curator tells me that two or three years back an attempt was made to introduce it into the pond of the new Botanic Garden, but without success. It is, I think, therefore worthy of record that this remarkable plant, so interesting to the biologist, has been lately discovered, apparently naturalised, at the bottom of the Ten Mile River, about twenty yards from the tidal waters of the Ouse.

The reappearance of Hydrodictyon on the fens round Cambridge is also interesting from the hope it inspires that, owing to the increased facilities for investigation now afforded by the University, further light may be thrown upon its singular cycle of development which, notwithstanding the labours of Areschoug, Cohn, Pringsheim, and others, must be said to be still somewhat obscure. J. C. SAUNDERS

Downing College, Cambridge, September 4

The Sky-Glows

THE sun-glow phenomena have entered upon such a fresh phase that I venture to send some extracts from my notes. It is not simply a renewal of the sunsets of last season, although that in itself will doubtless seem remarkable to those who have not noticed the almost constant occurrence of the "day glows" throughout the summer; the chief point is the radiating character.

September 11.—Glow 6.50 p.m. At 7 a vertical bar 2° to 3° across at base, to altitude 20°. Another at angle 45° to north; at 7.3 a third at angle 30° to north. The three faded at 7.5, 7.7, and 7.10.

September 12.—Sun seen to set by 6.20. At 6.35 ruddy tint above earth shadow in east; gone at 6.45. 6.50, fine glow from north-west to south-west, up to 30°; 6.55, very fine, up to 35°; much purple. Gradual change to low orange glow by 7.4, this fading by degrees, but partial return at 7.9; little left at 7.19.

September 13 (*sunrise*).—4.57 a.m., lovely orange glow and reflection in west. Cirri bright. 5.0, pink shot up vertically (in inverted pyramid) to height of Jupiter. 5.0½, bar at angle of 45° to north. 5.5, whole north-east to south east suffused, broken by dark bars, four to north, five to south, radiating from sun. Central mass now 5° to 10° above Jupiter. Cirri now dark at east, but slight tint near Venus (these proved to be higher and more feathery, the others about 7° or 8° above east by north, approaching to cirro-strati). 5.7, now five bars to north, seven to south. Light wider spread, now to level of Venus (roughly measured as 35°). Soon traces even to 45°. Bars *very* marked; one from east-north-east reaches north-north-east, at altitude about 22°. Low cirri now re-lit. 5.15, whole mass now barred; nine to north, and two new ones to south of centre, but lower part to south now gone. Cloud over Venus now re-lit. 5.20, going to west window find marked *counter-glow*, also barred, radiating from perspective just like bands of cirrus, yet marvellously clear sky. Four dark bands to south, five to north, wider than those seen in east, and definition much less distinct. Rosy tints now gone. A ruddy tinge almost from south to north above earth-shadow, *except just south of due west*, whence rose a broad dark vertical bar. Faint cirri to south now lit up. 5.28, bars to north and south still visible, and no glow above earth-shadow at anti-solar point. Glow lasting at 5.30. Cirri in east quite dark again, but the cirri near Venus and to south white. Former now in vertical lines, but upper edges blown in wisps towards north. 5.40, stratus low in east by south. A greenish cast given to Venus and Jupiter when the glow strongest. Rosy glow at times noticed during the day. Sun rose about 5.50.

Sun set before 6.20.—6.35, ruddy tinge along east horizon, keeping above earth-shadow as it ascends. 6.45½, cirro-stratus 5° to 10° above horizon, due west again lit up bright (first at 6.30) for two or three minutes, quickly followed by rosy glow in clear sky, as three central bands, divided by narrow dark bars,